AEC-NASA TECH BRIEF

Ion-Retarding Lens Improves the Abundance Sensitivity of Tandem Mass Spectrometers

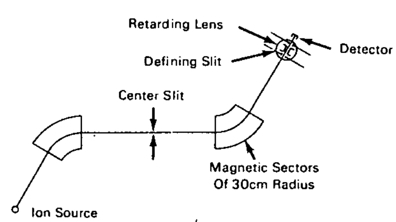

FIGURE 1. TANDEM MASS SPECTROMETER WITH THE RETARDING LENS IN POSITION

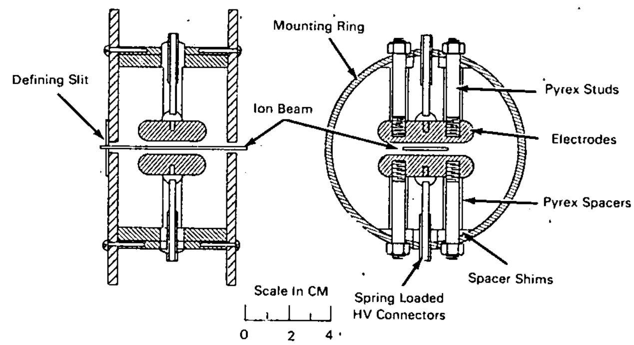

FIGURE 2. SECTION DRAWING OF RETARDING LENS. (ALL PARTS ARE OF PYREX OR TYPE 304 STAINLESS STEEL.)

This information should be of interest to manufacturers of mass spectrometers.

The problem:

To measure isotopes of very low abundance in mass positions adjacent to an isotope of high abundance. When the mass spectrum is scanned, "tails" are detected on either side of the mass position of the high-abundance isotope. These tails are frequently larger than the low-abundance isotopes being measured. One method used to reduce these "tails" employs a mass spectrometer containing two magnetic analyzers in tandem. The resulting "tail," however, is only slightly improved over that for a single stage.

The solution:

An ion-retarding lens which increases the abundance sensitivity of tandem magnetic-analyzer mass spectrometers. The simple and relatively inexpensive lens greatly increases the abundance sensitivity for those isotopes lying farther from the high-abundance isotope than the energy cutoff of the lens. The lens is a high-pass energy filter with a cutoff of about 40 volts below 13,000 volts, which is equivalent to about ⅔ of a mass unit at mass 250.

Under typical operating conditions in a 30-cm-radius, two-stage system, the abundance sensitivity improved by a factor of about 10 on the high-mass side and about 10^3 on the low-mass side.

How it's done:

The lens is of an einzel or unipotential type with thick center electrodes. The lens-focusing properties are derived from a two-dimensional potential field with an axis of symmetry by numerically integrating a paraxial trajectory equation.

The lens is placed between the spectrometer defining slit and the detector, the defining slit becoming part of the first lens electrode (Figure 1). A section drawing of the lens is shown in Figure 2. For an ion-accelerating voltage of 15 kV and about 40 V below

(continued overleaf)

15 kV (14,960 V) on the center electrodes, the lens focuses on the detector which is 8 cm. away. This lens, which operates at 15 kV, is only 6 cm long and is readily installed in an existing collector system.

The normal construction procedures used for any high-voltage apparatus were followed. Of most importance were: 1) rounding all corners and edges that "see" the high voltage, 2) electro-polishing all surfaces that "see" the high voltage, and 3) thoroughly ion-cleaning the lens before use.

The performance of the lens was determined by 1) applying the focus voltage to the center electrodes to turn the lens on, or 2) grounding the lens center electrodes, thereby effectively turning the lens off. These steps were performed alternately while holding the other instrument parameters constant.

Notes:

1. There may be some concern about the effect of the lens on relative peak intensities which are important in organic compound identification.
2. Complete details are available in ANL Report No. 7393, "Ion-Retarding Lens to Improve the Abundance Sensitivity of Tandem Mass Spectrometers." This report is available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price, $3.00 (microfiche copies, $0.65).
3. Inquiries concerning this information may be directed to:

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   Argonne National Laboratory
   9700 South Cass Avenue
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   Reference: B69-10166

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Patent status:

Inquiries concerning rights for commercial use of this innovation may be made to:

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